

B<sup>2</sup>  
cancel  
17. The urethane prepolymer according to claim 16, wherein said functional group is selected from the group consisting of a (meth)acryloyl group and a silyl group.--

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REMARKS

Upon entry of the present amendment, claims 1 and 9-17 will remain pending in the above-identified application.

In order to more clearly define the present invention, Applicants have instantly amended claim 1 so as to limit the range of number average molecular weight of component (B) (i.e., polyoxytetramethylene glycol (PTMG)) in the present invention more narrowly. Support for this amendment is found at page 21, lines 12 to 13 of the present specification.

Claims 2-8 have been cancelled and, instead, new claims 9-17 have been added. New claims 10-12 and 14-17 correspond to original claims 2-8 respectively. Each of new claims 9 and 13 is to define that the polyoxytetramethylene glycol (PTMG) used in the present invention is produced by the specific method. Support for each of new claims 9 and 13 is found at page 29, line 24 to page 35, line 2 of the present specification.

No new matter has been introduced.

A marked-up version of the amended claims and a list of pending claims are attached hereto.

In the outstanding Office Action issued on September 23, 2002, claims 1, 3, 4 and 6 have been rejected and claims 2, 5, 7 and 8 have been objected to.

Before specifically discussing the rejection of the claims, it is believed that the following background information should be considered in order to shed a proper light on the development of the present invention and the advantageous features thereof. As discussed in the specification under "Prior Art", in the production of polyether polyurethanes, various types of diols are used to control the properties thereof. For example, a low molecular weight diol is used in combination with a high molecular weight diol, such as a polyether diol, a polyester diol or a polycarbonate diol. Specific examples of polyether diols include polyoxyethylene glycol, polyoxypropylene glycol, polyoxytetramethylene glycol and modified high molecular weight diols obtained therefrom. Of the above-exemplified polyether diols, polyoxytetramethylene glycol (hereinafter, frequently referred to as "PTMG") has been used as a component constituting a soft segment of a shaped polyether polyurethane article or a polyether polyurethane elastic fiber since a long time ago.

A polyether polyurethane is produced from a polyisocyanate, a high molecular weight diol and a low molecular weight diol as main raw materials, and is a block copolymer having a soft segment composed mainly of the high molecular weight diol and a hard

segment composed mainly of the polyisocyanate and the low molecular weight diol. By virtue of such structure, the polyether polyurethane exhibits rubber elasticity. The chemical composition, polymer block length, and secondary and tertiary structures of the polyether polyurethane depend mainly on the types of the polyisocyanate and the high molecular weight diol used, and have a large influence on the physical properties of an ultimate polyether polyurethane product. Especially, the choice of the high molecular weight diol which is comprised in the soft segment is a very important factor in fields where a product obtained from a polyether polyurethane, such as an elastic fiber or a polyurethane elastomer, is required to have excellent and precisely controlled mechanical properties and viscoelastic properties.

Conventionally, the characteristics (such as molecular weight, molecular weight distribution, oligomer content and residual catalyst content) of the PTMG, which has been used as a high molecular weight diol are considered as important factors which affect the quality of the final polyether polyurethane. However, heretofore, no details are known in the art about how the characteristics of the PTMG influence the physical properties of the final polyether polyurethane. In addition, no polyether polyurethanes are known, which have been adjusted, by strictly controlling the characteristics of the raw material PTMG, so as to have a good balance of various excellent properties.

Nowadays, polyether polyurethane is an important material which is used in a wide variety of fields, and the application field thereof is expected to become more wide. Accordingly, there has always been a demand for improvement in the quality of the polyether polyurethane. Further, improvements in different properties of the polyether polyurethane are, respectively, desired in different application fields. For example, a polyether polyurethane used as a thermoplastic elastomer is required to exhibit high elastic modulus, excellent characteristics at low temperatures, small compression set, excellent surface touch with respect to an ultimate shaped product produced therefrom, and convenience in practical use of a coating composition containing the polyether polyurethane. Similarly, in the industrial fields related to a flexible foam and a rigid foam, an RIM (Reaction Injection Molding) product, an R-RIM (Reinforced Reaction Injection Molding) product, a coating composition, an adhesive, a binder, a sealant, a fiber stock, an artificial leather and a wide variety of other polyurethane products, and in various other industrial fields related to polyurethane urea products, there has been a demand for the improvements in the properties of a polyether polyurethane.

In this situation, the present inventors have made extensive and intensive studies with a view toward solving the above-mentioned problems. As a result, it has unexpectedly been found

that a polyether polyurethane, which comprises (A) at least one polyisocyanate having two or more isocyanate groups, which is selected from the group consisting of an aromatic polyisocyanate and an aliphatic polyisocyanate, (B) a polyoxytetramethylene glycol (PTMG) having a specific molecular weight, a specific molecular weight distribution and a specific content of high molecular weight molecules, which PTMG, notwithstanding low viscosity thereof, exhibits high heat resistance, and (C) at least one chain extender selected from the group consisting of a C<sub>2</sub>-C<sub>10</sub> polyol having two or more hydroxyl groups and a C<sub>2</sub>-C<sub>10</sub> polyamine having two or more amino groups,

wherein the PTMG has the following characteristics (1) to (3):

(1) a number average molecular weight of from 750 to 3,500;

(2) a molecular weight distribution of 1.75 or less in terms of the Mw/Mn ratio, wherein Mw represents the weight average molecular weight of PTMG and Mn represents the number average molecular weight of PTMG; and

(3) a content of high molecular weight PTMG molecules of 10 % by weight or less, based on the total weight of all PTMG molecules, wherein the high molecular weight PTMG molecules are defined as PTMG molecules having molecular weights which are at least six times as large as the number average molecular weight of all PTMG molecules,

exhibits high elastic modulus ( that is, a high elongation at break and a high tensile strength at break), excellent elastic properties at low temperatures and high flexibility, as compared to the conventional polyether polyurethanes. The present invention has been completed, based on this novel finding. As mentioned below, when the PTMG which is used as component (B) in the present invention does not satisfy even any one of the above-mentioned conditions (1) to (3), a polyether polyurethane which has excellent characteristics, such as the polyether polyurethane of the present invention, cannot be obtained. Further, it was for the first time been found that the PTMG which is used as component (B) in the present invention and which has excellent characteristics, can be produced only by the novel method as defined in each of new claims 9 and 13.

Referring now to the Examiner's rejection of the claims in the outstanding Office Action, Applicants' arguments against the rejection are given below in a paragraph-by-paragraph manner following the Examiner's paragraph Nos.

Para. 1

Examiner states;

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and

invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

In order to meet the Examiner's requirements of pointing out the inventors, the following table is provided.

Claim number	Inventors
Original claims 1 and 3	SHIMIZU and FURUKAWA
Original claim 2	SHIMIZU and FURUKAWA
Original claims 4 and 6	SHIMIZU and KATO
Original claim 5	SHIMIZU and FURUKAWA
Original claims 7 and 8	SHIMIZU and ASAHINA

Note: The names of the inventors are designated by the family names.

Para. 2 Claims 4 and 6 are rejected under 35 U.S.C. 102(b) as anticipated by JP 4-213316 or JP 4-8719.

Examiner states;

The references disclose the production of polyurethane prepolymers, wherein a polyisocyanate is reacted with a polytetramethylene ether glycol having a molecular weight and a molecular weight distribution which read on applicants' claims. Furthermore, the position is taken

that the claimed high molecular weight PTMG content is an inherent characteristic of the disclosed polytetramethylene ether glycols.

This rejection is traversed.

In the present invention, it is required that the PTMG which is used as component (B) in the present invention satisfies all of the above-mentioned three conditions, that is, (1) specific number average molecular weight ( $M_n$ ), namely a  $M_n$  of from 750 to 3,500, (2) specific molecular weight distribution, namely a molecular weight distribution of 1.75 or less, and (3) specific content of high molecular weight PTMG molecules, namely a content of high molecular weight PTMG molecules of 10 % by weight or less. The PTMG which satisfies the above-mentioned three conditions exhibits not only high heat resistance, but also low viscosity (see page 20, lines 15 to 20 of the present specification). Therefore, the urethane prepolymer of the present invention which comprises such a PTMG also has low viscosity. In addition, the urethane prepolymer of the present invention exhibits excellent compatibility with other resins, such as a fluorinated polyol (see page 46, lines 15 to 19 of the present specification). Further, when a composition, such as a coating composition, is prepared using the urethane prepolymer of the present invention, the prepared composition exhibits excellent properties (such as excellent fluidity before curing, excellent drying characteristic, and capability of forming a coating having no surface tack) (see



page 52, lines 3 to 9 of the present specification). Furthermore, when a urethane prepolymer is synthesized using above-mentioned PTMG, and the obtained urethane prepolymer is used for producing a polyether polyurethane, the produced polyether polyurethane exhibits a good balance of greatly improved properties as compared to that of a polyether polyurethane produced using a conventional PTMG. Illustratively stated, a polyether polyurethane produced using the urethane prepolymer of the present invention exhibits high elasticity and elastic recovery, low permanent compression set, and excellent low-temperature characteristics, as compared to those of the conventional polyether polyurethane (see page 44, line 22 to page 45, line 9 of the present specification). Further, when a shaped article is produced from the polyether polyurethane of the present invention, there is no tack on the surface of the produced shaped articles (see page 20, line 20 to page 21, line 7 of the present specification). To the contrary, as discussed below, though the component (B) used in the each of References 1 and 2 satisfies the above-mentioned conditions (1) and (2), each references does not teach or suggest the above-mentioned condition (3) and unexpected effects thereof.

Hereinbelow, an explanation is made with respect to a reason why the PTMG used in the present invention contributes to excellent characteristics of the polyether polyurethane of the present invention. When the PTMG used in the present invention satisfies

the above-mentioned condition (1) (the number average molecular weight of the PTMG is in the range of from 750 to 3,500), a polyether polyurethane produced using such a PTMG exhibits a good balance of flexibility and elastic modulus (see page 21, lines 8 to 13 of the present specification). Further, when the PTMG satisfies the above-mentioned condition (2) (the molecular weight distribution of the PTMG is 1.75 or less), the viscosity of the PTMG is satisfactorily low, and a polyether polyurethane produced using such a PTMG exhibits a good balance of excellent elongation at break and excellent tensile strength at break (see page 22, lines 11 to 16 of the present specification). Furthermore, the high molecular weight PTMG molecules are considered to improve the heat stability of the PTMG as a whole through an interaction with low molecular weight PTMG molecules which have high heat decomposability. Therefore, in the present invention, it is preferred that a small amount of high molecular weight PTMG molecules is present in the PTMG used (see page 25, lines 19 to 25 of the present specification). That is, when the PTMG satisfies the above-mentioned condition (3) (the content of high molecular weight PTMG molecules is 10 % by weight or less, based on the total weight of all PTMG molecules), such a PTMG has a uniform molecular weight distribution and has a low viscosity, as compared to a PTMG which, although it has the same molecular weight as that of the above-mentioned PTMG satisfying condition (3), but does not satisfy

condition (3). When such a PTMG is used in the polymerization reaction for producing a polyether polyurethane, a high polymerization rate can be achieved. In addition, the use of such a PTMG is also advantageous in that the obtained polyether polyurethane exhibits high elastic modulus (see page 24, last line to page 25, line 8 of the present specification).

Referring now to JP 4-213316 (hereinafter, referred to as "Reference 1"), this reference 1 discloses a polyurethane prepolymer which is produced using

(A1) paraphenylene diisocyanate, and

(B1) polytetramethylene ether glycol

wherein the component (B1) has a number average molecular weight of 1,100 or more and a molecular weight distribution of less than 2.0.

Therefore, the component (B1) satisfies the above-mentioned conditions (1) (a number average molecular weight of from 750 to 3,500) and (2) (a molecular weight distribution of 1.75 or less) of the present invention. However, Reference 1 does not teach or suggest the above-mentioned condition (3) (that is, a content of high molecular weight PTMG molecules is 10 % by weight or less, based on the total weight of all PTMG molecules, wherein the high molecular weight PTMG molecules are defined as PTMG molecules having molecular weights which are at least six times as large as the number average molecular weight of all PTMG molecules).

As mentioned above, the above-mentioned condition (3) of PTMG is one of the important factors for obtaining the urethane prepolymer of the present invention. This is apparent when comparison is made between Example 1 and Comparative Example 1 in the present specification. That is, the urethane prepolymer of the present invention which is obtained using a PTMG satisfying the above-mentioned condition (3) has excellent characteristics, as compared to the urethane prepolymer produced using a conventional PTMG not satisfying the above-mentioned condition (3).

Table 1 appearing at page 76 of the present specification shows PTMGs (A) to (P) which have different compositions. Of these, the PTMG (A) satisfies the condition (3) above. On the contrary, the PTMG (E) in Table 1 does not satisfy the condition (3) above. Further, Table 2 appearing at page 89 of the present specification shows the fluidity of prepolymer PA synthesized using PTMG (A) (Example 1) and the fluidity of prepolymer PE synthesized using PTMG (E) (Comparative Example 1). Table 3 appearing at page 90 of the present specification shows a drying characteristic of a sheet which is prepared using prepolymer PA and a drying characteristic of a sheet which is prepared using prepolymer PE. For easy reference, the data of Example 1 and the data of Comparative Example 1 shown in Tables 1 to 3 of the present specification are reproduced in Table A below.

Table A

		Example 1 of the present specification	Comp. Example 1 of the present specification
Prepolymer		PA	PE
PTMG used		A	E
Characteristic s of PTMG	Number average molecular weight (Mn)	1840	1897
	Molecular weight distribution (Mw/Mn)	1.60	2.51
	Content of high molecular weight PTMG molecules (% by weight)	2.29	13.39
Fluidity of the prepolymer		○	×
Drying characteristic		○	×

As shown in Table A, urethane prepolymer PA which is produced using PTMG (A) satisfying all of the above-mentioned conditions (1) to (3) exhibits not only an excellent fluidity but also a good drying characteristic.

On the other hand, urethane prepolymer PE which is produced using PTMG (E) which does not satisfy the above-mentioned condition (3) exhibits lower fluidity and drying characteristic, as compared to that of urethane prepolymer PA produced in Example 1.

As mentioned above, when the PTMG used as the component (B) satisfies the following conditions (1) to (3):

(1) a number average molecular weight of from 750 to 3,500;

(2) a molecular weight distribution of 1.75 or less in terms of the  $M_w/M_n$  ratio, wherein  $M_w$  represents the weight average molecular weight of PTMG and  $M_n$  represents the number average molecular weight of PTMG; and

(3) a content of high molecular weight PTMG molecules of 10 % by weight or less, based on the total weight of all PTMG molecules, wherein the high molecular weight PTMG molecules are defined as PTMG molecules having molecular weights which are at least six times as large as the number average molecular weight of all PTMG molecules, the urethane prepolymer which is produced using such a PTMG exhibits various excellent characteristics as mentioned above. Moreover, the polyether polyurethane which is produced using such a urethane prepolymer also exhibits various excellent characteristics.

As mentioned above, Reference 1 does not teach or suggest the above-mentioned condition (3) (the content of high molecular weight PTMG molecules is 10 % by weight or less). Therefore, the Reference 1 has no recognition with respect to an importance of the condition (3), so that not only the urethane prepolymer of the present invention but also the polyether polyurethane of the present invention is not taught or suggested by Reference 1.

Only by the method recited in new claim 13 of the present application, it has become possible to produce the PTMG which is used as the component (B) in the present invention and has various

characteristics (see page 29, line 24 to page 35, line 2 of the present specification). As described in the method recited in claim 13 of the present application, the molecular weight distribution, especially the content of high molecular weight PTMG molecules, of the produced PTMG can be adjusted by appropriately controlling the rate (F) ( $\text{m}^3/\text{hour}$ ) of feeding tetrahydrofuran (hereinafter, referred to as "THF") which is a raw material for a PTMG to the reactor, the motive power (P) (kW) applied to the liquid in the reactor (see page 31, lines 2 to 12 of the present specification). Among the above-mentioned synthesis conditions, when the value of the motive power P/V ( $\text{kW}/\text{m}^3$ ) is varied, the average particle diameters of globules of the aqueous THF/catalyst phase and the THF organic phase become varied. This variation in the average particle diameters of the globules is considered to result in a variation in the area of contact between the aqueous THF/catalyst phase and the THF organic phase, as well as a variation in the frequency of the coalescence and redivision of the above-mentioned globules, to thereby change the amounts of substances which are moving between the catalyst phase and the organic phase. Specifically, when the P/V value is increased, the amounts of substances which are moving between the catalyst phase and the organic phase become increased, and this increase causes the retention time of the THF monomer molecules in the catalyst

phase to become uniform. As a result, it is considered that the retention time distribution of THF in the catalyst phase becomes narrow and the number of high molecular weight PTMG molecules becomes decreased (see page 32, line 19 to page 33, line 13 of the present specification). The method recited in claim 13 has for the first time been established, based on the above-mentioned novel finding.

Reference 1 does not teach or suggest the importance and materiality of the method recited in claim 13 for obtaining the PTMG satisfying conditions (1), (2) and (3) simultaneously.

JP 4-8719 (hereinafter, referred to as "Reference 2") discloses a method for producing a polyurethane prepolymer using (A2) an organic polyisocyanate, and (B2) polytetramethylene ether glycol

wherein the component (B2) has a number average molecular weight of from 500 to 4,000 and a molecular weight distribution of from 1.2 to 2.0.

Therefore, the component (B2) satisfies the above-mentioned conditions (1) and (2) which are the conditions of the PTMG used in the present invention.

However, Reference 2 also does not teach or suggest the above-mentioned condition (3). In addition, Reference 2 also does not teach or suggest the importance and materiality of the method recited in claim 13 for obtaining the PTMG satisfying conditions



(1), (2) and (3) simultaneously.

Therefore, the urethane prepolymer of the present invention cannot be anticipated Reference 2.

Para. 3 Claims 1 and 3 are rejected under 35 U.S.C. 103(a) as unpatentable over JP 4-213316 or JP 4-8719.

Examiner states;

The references disclose the reaction of a prepolymer with a chain extender to yield a polyurethane polymer, wherein the prepolymer is produced from the reaction of a polyisocyanate with a polytetramethylene ether glycol having a molecular weight and a molecular weight distribution which meet applicants' claims. However, the references fail to disclose a chain extender having the claimed carbon chain length. The position is taken that chain extenders which meet those claimed by applicants were well known components for reaction with prepolymers to yield polyurethanes, at the time of invention. Such well known chain extenders are exemplified by ethylenediamine and butanediol. Therefore, it would have been obvious to utilize these chain extenders in place of the disclosed chain extenders, so as to arrive at the instant invention.

This rejection is traversed.

As mentioned in connection with Para. 2 above, it should be noted that the polyether polyurethane of the present invention is produced using a PTMG satisfying the above-mentioned conditions (1) to (3), wherein it is especially important that the PTMG satisfies the above-mentioned condition (3). That is, in the polyether polyurethane of the present invention, it is requisite to comprise, as component (B), a PTMG having a content of high molecular weight PTMG molecules of 10 % by weight or less, based on the total weight

of all PTMG molecules, wherein the high molecular weight PTMG molecules are defined as PTMG molecules having molecular weights which are at least six times as large as the number average molecular weight of all PTMG molecules, differing from each of the polyurethane elastomers of the cited References (References 1 and 2) which are produced using polytetramethylene ether glycol which satisfies the above-mentioned conditions (1) and (2) but does not satisfy the above-mentioned condition (3). Therefore, when each of the polyurethane elastomers in References 1 and 2 which are produced using the urethane prepolymers synthesized from polytetramethylene ether glycol which satisfies the above-mentioned conditions (1) and (2) but does not satisfy the above-mentioned condition (3) is reacted with the chain extender disclosed in the present invention, a polyurethane elastomer like the polyether polyurethane of the present invention which exhibits various excellent characteristics cannot be obtained.

Then, an explanation is made with respect to the effect of the PTMG used in the present invention on the excellent characteristics of the polyether polyurethane of the present invention. When the PTMG used in the present invention satisfies the above-mentioned condition (1) (a number average molecular weight of from 750 to 3,500), a polyether polyurethane produced using such a PTMG exhibits a good balance of flexibility and elastic modulus (see page 21, lines 8 to 13 of the present specification). Further,

when the PTMG used in the present invention satisfies the above-mentioned condition (2) (a molecular weight distribution of 1.75 or less), a polyether polyurethane produced using such a PTMG exhibits a good balance of excellent elongation at break and excellent tensile strength at break (see page 22, lines 11 to 16 of the present specification). Furthermore, the high molecular weight PTMG molecules are considered to improve the heat stability of the PTMG as a whole through the interaction with low molecular weight PTMG molecules which have high heat decomposability. Therefore, in the present invention, it is preferred that a small amount of high molecular weight PTMG molecules is present in the PTMG used (see page 25, lines 19 to 25 of the present specification). That is, when the PTMG used in the present invention satisfies the above-mentioned condition (3) (a content of high molecular weight PTMG molecules of 10 % by weight or less, based on the total weight of all PTMG molecules), such a PTMG is in the form of a uniform PTMG mixture and has a low viscosity, as compared to a PTMG which has the same molecular weight as that of the PTMG used in the present invention but does not satisfy the above-mentioned condition (3). When such a PTMG is used in the polymerization reaction for producing a polyether polyurethane, a high polymerization rate can be achieved. In addition, the use of such a PTMG is also advantageous in that the obtained polyether polyurethane exhibits high elastic modulus (see page 24, last line

to page 25, line 8 of the present specification).

Therefore, it should be noted that only when a polyether polyurethane is produced using a PTMG which satisfies the above-mentioned conditions (1) to (3) and has a low viscosity and a high heat stability, a polyether polyurethane which exhibits a good balance of greatly improved properties can be obtained, differing from the polyether polyurethane produced using a conventional PTMG. Illustratively stated, such a polyether polyurethane exhibits high elasticity and elastic recovery, low permanent compression set, and excellent low-temperature characteristics, as compared to those of the conventional polyether polyurethane. Further, the polyether polyurethane of the present invention can be used for forming a coating which has no tack on the surface thereof and is unlikely to suffer discoloration. On the other hand, when a PTMG which does not satisfy the above-mentioned condition (1) is used, the flexibility and the elastic modulus of the polyether polyurethane becomes low (see page 21, line 21 to page 22, line 1 of the present specification). When a PTMG which does not satisfy the above-mentioned condition (2) is used, the mechanical properties (such as strength and elongation) of the polyether polyurethane become low. In addition, since the soft segment composed of a PTMG having a broad molecular weight distribution which does not satisfy condition (2) inevitably contains a large amount of high molecular weight PTMG molecules, the high molecular weight PTMG molecules

hinder the phase separation of the soft segment and the hard segment in the polyether polyurethane, thereby causing the low-temperature characteristics of the polyether polyurethane to become poor (see page 22, line 16 to page 23, line 4 of the present specification). Further, when a large amount of high molecular weight PTMG molecules is contained in the PTMG, the high molecular weight PTMG molecules hinder the phase separation of the soft segment and the hard segment in the polyether polyurethane (see page 23, lines 21 to 25 of the present specification).

Referring now to JP 4-213316 (Reference 1), this Reference 1 discloses a polyurethane elastomer which is produced using

- (A1) paraphenylene diisocyanate
- (B1) polytetramethylene ether glycol and
- (C1) 4,4'-methylenebis(o-chloroaniline),

wherein the component (B1) has a number average molecular weight of 1,100 or more and a molecular weight distribution of less than 2.0.

Therefore, the component (B1) satisfies the above-mentioned conditions (1) (a number average molecular weight of from 750 to 3,500) and (2) (a molecular weight distribution of 1.75 or less) of the present invention. However, Reference 1 does not teach or suggest the above-mentioned condition (3) (that is, a content of high molecular weight PTMG molecules is 10 % by weight or less, based on the total weight of all PTMG molecules, wherein the high

molecular weight PTMG molecules are defined as PTMG molecules having molecular weights which are at least six times as large as the number average molecular weight of all PTMG molecules).

As mentioned above, the above-mentioned condition (3) of PTMG is one of the important factors for obtaining the polyether polyurethane of the present invention. This is apparent when comparison is made between Example 5 and Comparative Example 7 in the present specification. That is, the polyether polyurethane of the present invention which is obtained using a PTMG satisfying the above-mentioned condition (3) has excellent characteristics, as compared to the polyether polyurethane produced using a conventional PTMG not satisfying the above-mentioned condition (3).

Table 1 appearing at page 76 of the present specification shows PTMGs (A) to (P) which have different compositions. Of these, the PTMG (A) satisfies the condition (3) above. On the contrary, the PTMG (E) in table 1 does not satisfy the condition (3) above. Further, Table 5 appearing at page 98 of the present specification shows a difference in characteristics between a polyether polyurethane obtained using PTMG (A) (Example 5) and a polyether polyurethane obtained using PTMG (E) (Comparative Example 7). For easy reference, the data of Example 5 and the data of Comparative Example 7 shown in Tables 1 and 5 of the present specification are reproduced in Table B below.

Table B

		Example 5 of the present specification (PTMG(A) is used)	Comp. Example 7 of the present specification (PTMG(E) is used)
Content of high molecular weight PTMG molecules (% by weight)		2.29	13.39
Polyether polyurethane	Tensile strength at break (kgf/cm <sup>2</sup> )	510	447
	Elongation at break (%)	610	580
	Dunlop impact Resilience	67.5	66.4

As shown in Table B above, the polyether polyurethane which is produced using PTMG (A) satisfying the above-mentioned conditions (1) to (3) exhibits a tensile strength at break of 510 kgf/cm<sup>2</sup>, an elongation at break of 610 % and a dunlop impact resilience of 67.5, showing that the polyether polyurethane of the present invention exhibits excellent characteristics.

On the other hand, the polyether polyurethane which is produced using PTMG (E) not satisfying the above-mentioned condition (3) exhibits a tensile strength at break of 447 kgf/cm<sup>2</sup>, an elongation at break of 580 % and a dunlop impact resilience of 66.4, showing that the conventional polyether polyurethane produced in Comparative Example exhibits poor characteristics as compared to the polyether polyurethane produced in Example 5.

As clearly shown above, when the PTMG used as the component (B) satisfies the following conditions (1) to (3):

- (1) a number average molecular weight of from 750 to 3,500;
- (2) a molecular weight distribution of 1.75 or less in terms of the  $M_w/M_n$  ratio, wherein  $M_w$  represents the weight average molecular weight of PTMG and  $M_n$  represents the number average molecular weight of PTMG; and

(3) a content of high molecular weight PTMG molecules of 10 % by weight or less, based on the total weight of all PTMG molecules, wherein the high molecular weight PTMG molecules are defined as PTMG molecules having molecular weights which are at least six times as large as the number average molecular weight of all PTMG molecules, the polyether polyurethane which is produced using such a PTMG exhibits various excellent characteristics as mentioned above.

As mentioned above, Reference 1 does not teach or suggest the above-mentioned condition (3) (the content of high molecular weight PTMG molecules is 10 % by weight or less). Therefore, the Reference 1 has no recognition with respect to an importance of the condition (3). That is, the polyether polyurethane of the present invention is not taught or suggested by Reference 1.

Only by the method recited in new claim 9 of the present application, it has for the first time become possible to produce the PTMG which is used as the component (B) in the present



invention and has various characteristics (see page 29, line 24 to page 35, line 2 of the present specification). As described in the method recited in claim 9 of the present application, the molecular weight distribution, especially the content of high molecular weight PTMG molecules, of the produced PTMG can be adjusted by appropriately controlling the rate (F) ( $\text{m}^3/\text{hour}$ ) of feeding tetrahydrofuran (hereinafter, referred to as "THF") which is a raw material for a PTMG to the reactor, the motive power (P) (kW) applied to the liquid in the reactor, and the volume (V) ( $\text{m}^3$ ) of the liquid in the reactor (see page 31, lines 2 to 12 of the present specification). Among the above-mentioned synthesis conditions, when the value of the motive power  $P/V$  ( $\text{kW}/\text{m}^3$ ) is varied, the average particle diameters of globules of the aqueous THF/catalyst phase and the THF organic phase become varied. This variation in the average particle diameters of the globules is considered to result in a variation in the area of contact between the aqueous THF/catalyst phase and the THF organic phase, as well as a variation in the frequency of the coalescence and redivision of the above-mentioned globules, to thereby change the amounts of substances which are moving between the catalyst phase and the organic phase. Specifically, when the  $P/V$  value is increased, the amounts of substances which are moving between the catalyst phase and the organic phase become increased, and this increase causes

the retention time of the THF monomer molecules in the catalyst phase to become uniform. As a result, it is considered that the retention time distribution of THF in the catalyst phase becomes narrow and the number of high molecular weight PTMG molecules becomes decreased (see page 32, line 19 to page 33, line 13 of the present specification). The method recited in claim 9 has for the first time been established, based on the above-mentioned novel finding.

Reference 1 does not teach or suggest the importance and materiality of the method recited in claim 9 for obtaining the PTMG satisfying conditions (1), (2) and (3) simultaneously.

JP 4-8719 (Reference 2) discloses a method for producing a polyurethane elastomer using

- (A2) an organic polyisocyanate, and
- (B2) polytetramethylene ether glycol and
- (C2) an aromatic polyamine

wherein the component (B2) has a number average molecular weight of from 500 to 4,000 and a molecular weight distribution of from 1.2 to 2.0.

Therefore, the component (B2) satisfies the above-mentioned conditions (1) and (2) which are the conditions of the PTMG used in the present invention.

However, Reference 2 also does not teach or suggest the above-mentioned condition (3). In addition, Reference 2 also does not

teach or suggest the importance and materiality of the method recited in claim 9 for obtaining the PTMG satisfying conditions (1), (2) and (3) simultaneously.

Therefore, the polyether polyurethane of the present invention is not obvious over the Reference 2.

From the foregoing, it is apparent that the present invention is patentably distinct from any of the cited references and all rejections in the outstanding Office Action should be withdrawn. It is firmly believed that a patentability of the present invention has now been established.

Early favorable action is hereby respectfully solicited.

#### CONCLUSION

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact John W. Bailey (Reg. No. 32,881) at the telephone number below, to conduct an interview in an effort to expedite prosecution in connection with the present application.

**Attached hereto is a marked-up version of the changes made to the application by this Amendment.**

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees

required under 37 C.F.R. §§ 1.16 or 1.17; particularly, extension of time fees.

Respectfully submitted,

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By 

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Attachment: Version with Markings to Show Changes Made

(Rev. 02/20/02)

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Claims 2-8 have been canceled.

The claims have been amended as follows:

1. (Amended) A polyether polyurethane comprising:

(A) at least one polyisocyanate having two or more isocyanate groups, which is selected from the group consisting of an aromatic polyisocyanate and an aliphatic polyisocyanate;

(B) a polyoxytetramethylene glycol (PTMG); and

(C) at least one chain extender selected from the group consisting of a C<sub>2</sub>-C<sub>10</sub> polyol having two or more hydroxyl groups and a C<sub>2</sub>-C<sub>10</sub> polyamine having two or more amino groups,

wherein said PTMG has the following characteristics (1) to (3):

(1) a number average molecular weight of from [500 to 4,000]  
750 to 3,500;

(2) a molecular weight distribution of 1.75 or less in terms of the Mw/Mn ratio, wherein Mw represents the weight average molecular weight of PTMG and Mn represents the number average molecular weight of PTMG; and

(3) a content of high molecular weight PTMG molecules of 10 % by weight or less, based on the total weight of all PTMG molecules, wherein said high molecular weight PTMG molecules are

defined as PTMG molecules having molecular weights which are at least six times as large as the number average molecular weight of all PTMG molecules.

Claims 9-17 have been added.